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An Analysis of US Export and Air Transport Policy

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Abstract: Today, in major economies, air cargo service is intensively used for transport of international merchandise trade. The need for high-speed cross-boarder transport has been accelerated by strategic emphasis on supply chain management (SCM) in the manufacturing sector. Air cargo service has become an integral part of the linkage system for SCM. Although there is growing attention on the importance of air transport and international trade, there is a missing link in empirical analysis between the two. This paper tries to fill the gap from two aspects by estimating export demand function and air transport supply function with a simultaneous equation model using US export data with twenty-one trading partners for 1998 – 2002. We first find that airfare is more significantly correlated with export than distance. Second, the level of market concentration computed as Herfindahl-Hirschman Index (HHI) has significant positive effect on airfare. Assuming Cournot competition, Price-Cost Margin of US export markets with twenty-one nations ranges from 0.05 to 0.75. Strikingly, HHI is higher for air cargo markets with trading partners that have concluded Open Sky Agreements with US. We need to go beyond Open Skies if we are to seriously pursue enhancement of competitive forces in air cargo market to facilitate international trade[1].

Keywords: Merchandise trade, gravity model, air cargo, Open Sky Policy.

JEL Classification: L93, F14, L50

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[1] The original paper was presented at 2006 ATRS World Conference, Nagoya. Comments and suggestions are welcomed. Not to be quoted without author's consent.

Introduction

Manufacturing of modern merchandise is characterized by cross-border investment and division of labor. Efficient supply chain that links between facilities in different locations enables strategic marketing that requires feedback from down stream to up stream of value chain. Air cargo serves as an indispensable mean of logistics in today's manufacturing. By expeditious and reliable transport service manufacturing sector could avoid risk of holding inventory as well as to penetrate into final markets quickly. In major states such as US and Japan about 30% of internationally traded merchandise, in ad-valorem, is transported by air. By looking at goods traded by air cargo, we could see the forerunners of business segments in these economies as well as to identify transport policy that would facilitate international trade.

This paper has two sections. First, we briefly look at US merchandise trade and transport mode in comparison with Japan. Second, by using a gravity model we analyze the relevance of distance and airfare between nations with regards to trade by air transport and discuss the effect of public policy such as US Open Sky Policy.

1. US Trade and transport mode: a comparison with Japan

Common perception of international merchandise trade of US and Japan may be different. Composition of transport mode for trade, however, is quite similar. While US have land-transport and Japan does not for international trade, the share of air transport is about the same at approximately thirty percent. Details of merchandise trade transported by air are somewhat different. For

All mode of transport

	U.S.A		JAPAN	
1	CANADA	20.0%	U.S.A	23.4%
2	MEXICO	12.5%	CHINA	13.5%
3	JAPAN	9.3%	S. KOREA	5.8%
4	CHINA	7.9%	TAIWAN	5.3%
5	GERMANY	4.8%	HONG KONG	3.6%
6	ENGLAND	4.0%	GERMANY	3.5%
7	S. KOREA	3.1%	THAILAND	3.1%
8	TAIWAN	2.7%	AUSTRALIA	3.0%
9	FRANCE	2.6%	MALAYSIA	2.9%
10	ITALY	1.9%	INDONESIA	2.7%
	OTHERS	31.2%	OTHERS	33.1%

Air transport

	U.S.A		JAPAN	
1	JAPAN	11.0%	U.S.A	26.4%
2	ENGLAND	7.8%	CHINA	9.5%
3	GERMANY	6.8%	TAIWAN	8.6%
4	CHINA	5.2%	S. KOREA	6.9%
5	FRANCE	5.1%	HONG KONG	5.5%
6	IRELAND	5.0%	GERMANY	4.9%
7	TAIWAN	4.9%	SINGAPORE	4.7%
8	S. KOREA	4.9%	PHILIPPINE	3.9%
9	MALAYSIA	4.5%	MALAYSIA	3.7%
10	SINGAPORE	4.2%	THAILAND	3.1%
	OTHERS	40.6%	OTHERS	22.8%

Figure 1 Share of Total Trade (ad-valorem) (2002)

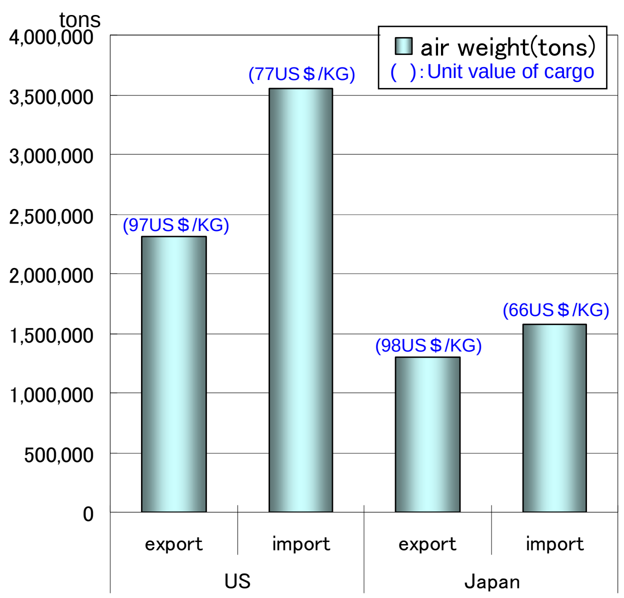

Figure 2 Volume of Trade in weight (2002)

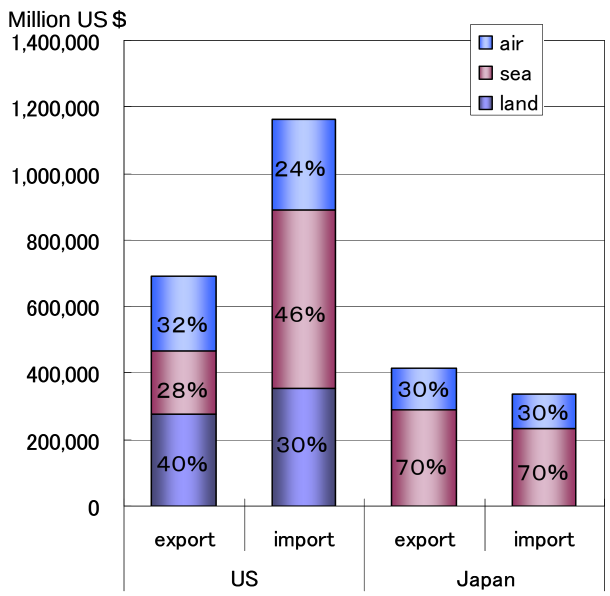

Figure 3 Volume of Trade in ad-valorem (2002)

instance, 40% of machinery in US export is aircraft related whereas in Japan only 5% is in the same category. Another area of difference is in precision instrument. Nearly half of precision instrument in US export is medical related, while Japanese export is more diverse. As for import, US imports large volume of bio-chemicals and medicines from Europe, whereas Japanese import in this segment is relatively small. However, composition of merchandise at a more aggregate level has similar characteristics. In both countries 80% of export and 60% of import is machinery. Also, price of the traded goods per weight is similar at 97-98 US$/Kg for export and 66-77 US$/Kg for import (Figure 1 – Figure 4). In the following section, we look further into US export and relationship between international trade, air cargo and air transport policy.

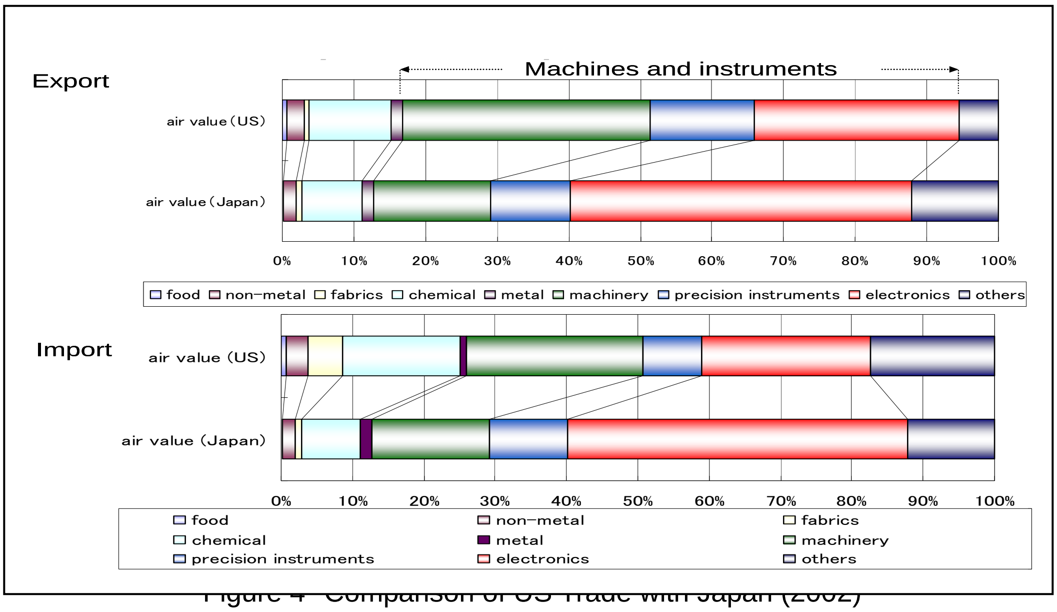

Figure 4 Comparison of US Trade with Japan (2002)

2. Analysis of US Export and the Air Cargo Market

Distance between nations is one of the major factors that affect trade. Disdier et al (2005) reviewed 1,467 results from 103 papers on international trade. From this meta-data, average distance elasticity on trade was found to be -0.9. Due to recent development in transport, impact of distance may have diminished while cost of transport is gaining relevance to trade. Until recently, however, there have not been many attempts to consider transport in international trade theories. Hummels (1999), Liamo and Venables (2001), Harrigan (2005) are some of recent analyses that discuss trade and transport cost, but these studies are not focusing on implications for transport policy.

Transport studies, on the other hand, has considerable work on demand analysis. Oum et al (1990) sites three studies on price elasticity of air cargo that range from –0.82 to –1.60. Linkage between transport policy and trade, however, has not been fully analyzed in transport research either.

In this section we use a gravity model to integrate assessment of trade flows and transport. Through this analysis, we compare distance with airfare as an index of transaction cost of trade in the model and discuss public policy implications.

1) The Model

i) Export Demand

Gravity model is used to express demand function of export. Here we consider US export by air transport in ad-valorem. Usual gravity model uses product of GDPs of the country pairs, however, we drop US GDP for simplicity, since we are concentrating on US export. Note that only trade volume transported by air is taken into account. GDP is broken down into per capita GDP and population in order to reflect level of development[2] and size of the economy. Subsequent equations are expressed in log-linear form.

$$lairvalue_{it} = c_1 + \alpha_1 \lg dppercapita_{it} + \alpha_2 lpopulation_{it} + \alpha_3 ldis\tan ce_i + \varepsilon_{it} \text{......(1)}$$

where,

$airvalue_{it}$: US export in ad-valorem to country i in year t transported by air.

$gdppercapita_{it}$: per capita GDP of country i in year t.

$population_{it}$: population of country i in year t.

$dis\tan ce_i$: distance between US and country i.

c : constant.

ε_{it}: μ_i (fixed effect) + v_t (year dummy) + u_{it} (error term).

In gravity models, distance is considered as an index of spatial transaction cost. Alternatively, cif/fob is often used to capture aggregate transport cost. Since we are focusing on transport cost in the narrow sense, instead of taking cif/fob we replace distance with airfare. Airfare could be regarded as "c" in cif for trade in air transport. Thus, we have the following equation.

$$lairvalue_{it} = c_2 + \alpha_4 \lg dppercapita_{it} + \alpha_5 lpopulation_{it} + \alpha_6 lyield_{it} + \varepsilon_{it} \text{........(2)}$$

where,

$yield_{it}$: average yield, i.e., average airfare (in US$ per Kg), from US to country i in year t.

ii) Air Transport Supply Function

Since output of air cargo market is captured by weight or product of weight and distance rather than by value of transported goods, air transport supply function for exported goods is expressed as follows. Herfindahl- Hirschman Index (HHI) of air cargo market is incorporated to reflect level of competition in the segment.

$$lyield_{it} = c_3 + \gamma_1 ldis\tan ce_{it} + \gamma_2 lairweight_{it} + \gamma_3 lairhhi_{it} + \varepsilon_{it} \text{........(3)}$$

where,

$airweight_{it}$: US export in weight (Kg) to country i in year t transported by air.

$airhhi_{it}$: Herfindahl-Hirschman Index, sum of airline's market share in weigh squared, of air cargo market from US to country i in year t.

[2] Per capita GDP could also be regarded as a proxy for consumption patterns or "tastes" of that nation.

iii) Market Conditions

Also, we check the relationship between per unit value of exported merchandise with respect to distance and transport cost. Per unit cost such as transport cost should induce demand from far away locations to center around relatively expensive merchandise per weight. Since demand for relatively expensive merchandise is higher in developed economy, we hold per capita GDP constant, and we assume value per Kg of exported merchandise to be a function of distance or airfare. "Airfare" should be as significant as "distance" since far away locations would be more expensive to ship the goods. We would, therefore, have the following two functions.

$$lunitvalue_{it} = c_4 + \eta_1 \lg dppercapita_{it} + \eta_2 distance_i + \varepsilon_{it} \text{........(4)}$$

$$lunitvalue_{it} = c_5 + \eta_3 \lg dppercapita_{it} + \eta_4 yield_{it} + \varepsilon_{it} \text{........(5)}$$

Finally, we look at correlation between HHI and Open Sky Agreement with US. While holding the trade volume constant, the dummy variable could identify whether an Open Sky Agreement leads to enhanced level of competition or provides a market for oligopoly.

$$lairhhi_{it} = c_6 + \delta_1 lairvalue_{it} + \delta_2 dum1_t + \varepsilon_{it} \text{........(6)}$$

$$lairhhi_{it} = c_7 + \delta_3 lairweight_{it} + \delta_4 dum1_t + \varepsilon_{it} \text{........(7)}$$

where,

$dum1_t$: Dummy for nation that have Open Sky Agreement with US in year t.

We expect the following for the parameters;

$\alpha_1, \alpha_2, \alpha_4, \alpha_5, \beta_1, \beta_2, \beta_4, \beta_5 > 0$, $\alpha_3, \alpha_6, \beta_3, \beta_6 < 0$

$\gamma_1 > 0$, $\gamma_2 > 0, or, < 0$, $\gamma_3 > 0$

$\delta_1, \delta_3 < 0$, $\delta_2, \delta_4 > 0, or, < 0$, $\eta_1, \eta_2, \eta_3, \eta_4 > 0$

2) Data

Data for twenty-one US export partners[3] were compiled from US Export of Merchandise 1998 – 2002 (US Census Bureau), Air Cargo Annual 1999-2003 (IATA), World Economic Indicators (World Bank), Form 41 (T100) of Air Carrier Statistics (Bureau of Transport Statistics, US DOT). Data for years from 1998 to 2002 were collected. IATA Air Cargo Annual, which is the source of average fare for air cargo, is terminated since 2003. Distance is the great circle distance between geographical centers of the nations. In 2002, US export was 693 billion US$ and 320 million tons[4]. Those transported by air were 225 billion US$ (32.5%), 2,310 thousand tons (0.7%). Export by air to the twenty-one nations are 126

[3] The twenty-one nations are Canada, Mexico, Peru, Venezuela, Brazil, Chile, Argentina, United Kingdom, Germany, Israel, Saudi Arabia, South Africa, Nigeria, Hong Kong, Singapore, India, Pakistan, Japan, South Korea, Australia, and New Zealand. They were selected to have balance between continents and data availability.

[4] Weights are total volume of export transported by air and sea. Land transported volume is not reported.

billion US$ (55.9% of US export in ad-valorem by air), 1410 thousand tones (61.2% of US export by air in weight).

Add-on cost of trade from airfare ranges from 0.7% to 6.3% with weighted average of 1.3%. This average add-on cost of trade from airfare accounts for 12% - 13% of cif/fob ratio of 8 - 11% that Harrigan (2005) estimated for US imports. Other than airfare, packaging and delivery cost, customs and insurance compose the total tangible transport cost[5].

3) Econometric Issues

In analyzing the panel data, we used the random effect model and the fixed effect model. Hausman test supported the random effect model. This is plausible since the twenty-one nations were selected in a random manner and that relationship between trade and transport should hold in general rather than as a unique correlation for the twenty-one nations.

Considering simultaneity of demand and supply functions, simultaneous equation models for (2) and (3) are estimated by Two Step Lease Squared Panel Estimation (2SLS Panel) based on Baltagi (2001). In case where distance, which is one of the fixed effects, enters the model, in addition to the Random Effect Panel Estimation (RE) we used the Maximum Likelihood Estimation (MLE) to enhance robustness of the regression analysis[6].

4) Empirical Findings

First, the results of the regressions on distance are summarized in Table 1. Sign of the parameters are as we expected. When we take natural log of ad-valorem US export by air transport (*lairvalue*) as dependent variable, coefficients for natural log of distance (*ldistance*) were -0.323 (RE) and -0.327 (MLE), although their statistical significance are rather low. Compared to the mean distance elasticity of -0.9 reported in meta-data analysis by Disdier et al (2005), elasticity is lower. This suggests that there are other variables that better reflect the resistance factor in the gravity model for the trade by air transport.

So we turn to the simultaneous equation models. The results are reported in Table 2. Elasticity of airfare with respect to export in ad-valorem (*airvalue*) was -1.227. Holding export volume constant, elasticity of HHI (*airhhi*) with respect to airfare (*yield*) was 0.113 and statistically significant. Elasticity of airfare with distance was 0.227.[7] Dummy variables for years 2001 and 2002 were significant reflecting macro-economic shocks from 911 terrorist's attack etc.

Table 3 shows that per unit value of merchandise exported by air transport are higher for distant destinations. Coefficient for airfare was statistically more significant than distance implying that source of per unit cost that leads to this phenomenon is captured more appropriately by the actual shipping cost (*airfare*) rather than by distance.

In Table 4, Pooled OLS for HHI and Open Sky dummy variable is listed. Strikingly, we can see that there is a positive correlation between them. Random effect model and the fixed effect model of panel data analysis, however, did not result in significant outcome. To check whether Open Sky dummy had direct impact on the level of airfare, we replaced the HHI with Open Sky dummy variables in 2SLS Panel equation (3). The result showed positive and statistically significant correlation between the Open Sky dummy and airfare.

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[5] There are intangible costs associated with international trade such as time factor and communication barriers.

[6] We also tested the GMM approach, although due to data constraints, there was no statistically significant finding.

[7] This is within the bounds of results achieved by Hummels (1999).

5) Public Policy Implications

Assuming Cournot competition, following relationship between HHI and Price-Cost Margin would stand[8].

$$-\frac{HHI}{\varepsilon} \equiv -\frac{\sum_i s_i^2}{\varepsilon} = \sum_i s_i \frac{p-m}{p}$$

where, ε is elasticity of demand, s_i is output share of firm i, p is airfare, m is marginal cost. Computed from the estimated parameter for ε, Price-Cost Margin of twenty-one US air cargo markets ranges from 0.05 to 0.75 (Figure 5). There is a general tendency that price-cost margin decreases as volume increases, although there is variance particularly on the lower band of the volume.

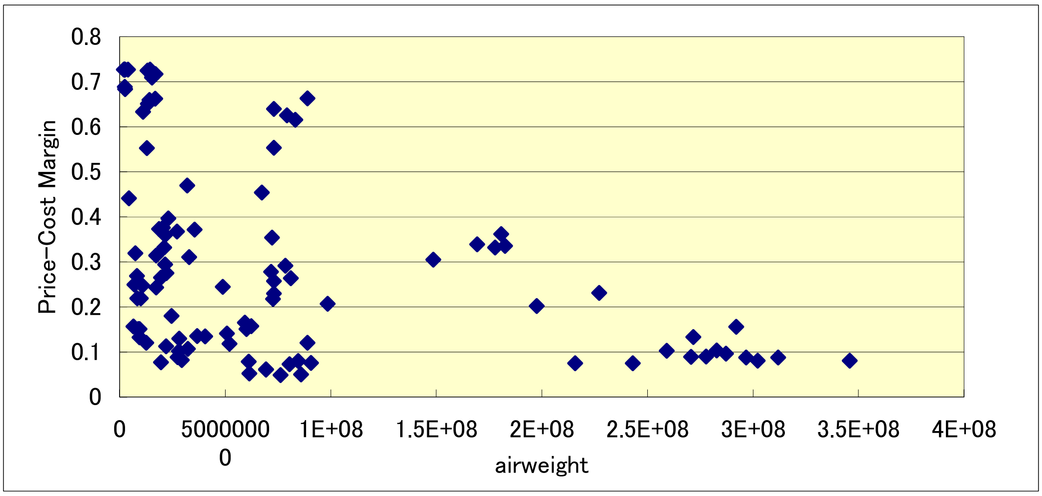


Figure 5 Price-Cost margin and Trade Volume for US export by air with twenty-one nations (1998-2002)

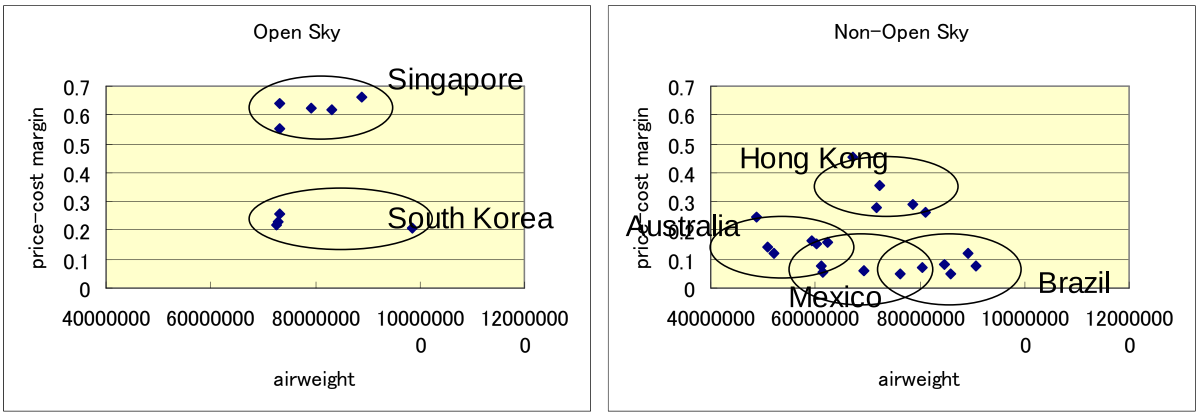
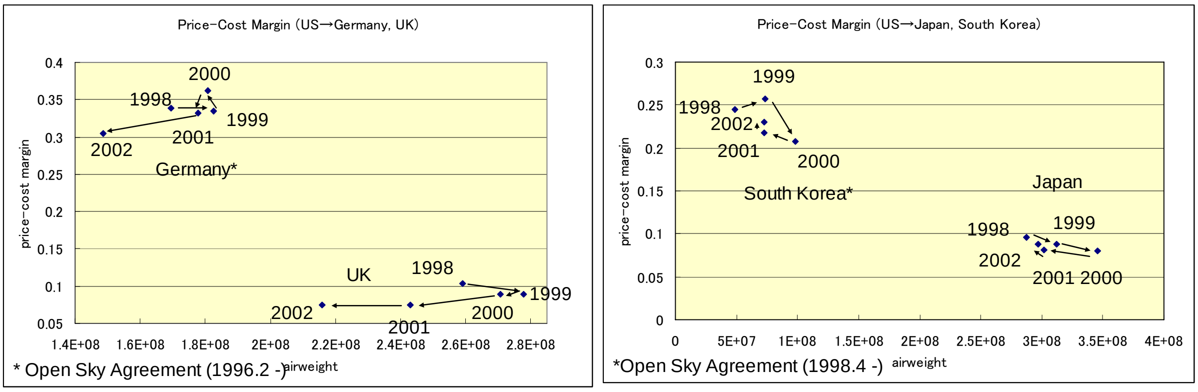


Figure 6 Price-Cost margin and Trade Volume for US export by air with six nations (1998-2002)

We expected that pro-competitive policy such as Open Sky Policy would drive

[8] See Carlton and Perloff (2005) for details.

price-cost margin down. This, however, was not the case and strikingly, HHI is higher for air cargo markets with trading partners that have concluded Open Sky Agreements with US. By taking six nations in the bound of 40 million to 100 thousand tons per annum, we can clearly see that non-Open Sky markets have in fact lower price-cost ratio (Figure 6). This could also be depicted for markets in the same geographical region, such as US-Japan / US-South Korea and US-UK / US-Germany, although there is difference in trade volume (Figure 7).



and Trade Volume for US-Japan / US-South Korea and
JK / US-Germany (1998-2002)

3. Concluding Remarks

Through this analysis, we have confirmed the strategic importance of air transport for the leading manufacturing industries. Today, air cargo is an integral part of SCM for high-end products. This paper revealed that airfare is more significantly correlated with volume of trade than distance. Also, competitive force in the international air cargo market is all the more important for international trade. Direct impact of market concentration on the level of airfare was manifested. Assuming Cournot competition, Price-Cost Margin in the twenty-one air cargo markets ranges from 0.05 to 0.75.

The most strikingly finding is that market concentration is higher, thus the level of airfare is relatively higher, for air cargo markets with trading partners that have concluded Open Sky Agreements with US. We need to go beyond Open Skies if we are to seriously pursue enhancement of market forces to facilitate international trade. We point out three caveats in considering policies beyond Open Skies.

First is the effect of the rigid framework of international air transport. Air transport has traditionally been provided under a framework in which international and domestic activities are segregated. In particular, cabotage, which is solely reserved for national air carriers, could be serving as an anti-competitive factor. Domestic segment, which is not exposed to international competition, not only serves as an important segment for the door-to-door service in international air transport but also as a source of economic rent from externalities that could be internalized by these national oligopolies.

Second is collusive relationship among international air cargo carriers. In fact, there have been cases under investigation by the anti-trust institutions on alleged international cartel. We need to take uncompromising action against such suspicious incidents and need to scrutinize activities in international institutions such as IATA and individual international air cargo alliances.

Third is landing slots at congested airports. From our data, markets such as US-Japan and US-UK with highly saturated Narita and Heathrow had relatively low HHI. We need to keep an eye on this issue. In the presence of airport congestion new and growing airlines are forced to refrain for providing competitive services. This, however, should not be an excuse for not undertaking further steps in liberalization. Ingenuity in economic approach should pave the way to cope with congestion.

In sum, enhancement of competitive forces in the transport sector would facilitate international trade. We still need to go a long way, however, before being able to sit back and be comfortable with market performance in international trade and air cargo.

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Table 1 Panel (Random Effect (re), Maximum Likelihood (mle))

dependent variable	independent variable										n=105
	lgdppercapita	*t-stats*		*lpopulation*	*t-stats*		*ldistance*	*t-stats*		*year*	R2
re lairvalue	1.763	9.47	***	0.595	4.26	***	−0.323	−1.08		02	0.817
mle lairvalue	1.75	10.28	***	0.588	4.67	***	−0.327	−1.23		02	−
re lairweight	1.593	9.81	***	0.601	4.94	***	−0.51	−1.96	**	01, 02	0.837
mle lairweight	1.557	10.61	***	0.583	5.46	***	−0.522	−2.34	**	01, 02	−

***: significant at 1% level **: siginificant at 5% level *: significant at 10% level

Year : statistically significant (5% level) year dummy.

Table 2 Panel (Random Effect 2SLS(re), Fixed Effect (fe))

function 1 dependent variable	independent variable										n=105
	lgdppercapita	*t-stats*		*lpopulation*	*t-stats*		*lyield*	*t-stats*		*year*	R2
re lairvalue #	1.465	6.02	***	0.511	3.16	***	−1.22664	−2.67	***	02	0.829
	Hausman specification test wrt fe: chi2(7)=2.65 Prob>chi2=0.913										−
function 2 dependent variable	**independent variable**										**n=105**
	ldistance	*t-stats*		*lairweight*	*t-stats*		*lairhhi*	*t-stats*		*year*	R2
re lyield #	0.227	1.78	*	−0.103	−1.95	*	0.113	1.69	*	01, 02	0.503
	Hausman specification test wrt fe: chi2(6)=3.98 Prob>chi2=0.679										−

***: significant at 1% level **: siginificant at 5% level *: significant at 10% level

Instrumental variables: *lgdppercapita, lpopulation, ldistance, lairhhi, year dummies*

Year : statistically significant (5% level) year dummy.

Table 3 Panel (Random Effect (re), Maximum Likelihood (mle))

dependent variable	independent variable										n=105
	ldistance	*t-stats*		*lyield*	*t-stats*		*lgdppercapita*	*t-stats*		*year*	R2
re lunitvalue	0.193	1.63					0.192	2.95	***	00, 01	0.398
mle lunitvalue	0.193	1.77	*				0.194	3.2	***	02	−
re lunitvalue				0.15	1.98	**	0.209	3.04	**	00, 01, 02	0.342
mle lunitvalue				0.151	2.05	**	0.21	3.26	***	00, 01, 02	−

***: significant at 1% level **: siginificant at 5% level *: significant at 10% level

Year : statistically significant (5% level) year dummy.

Table 4 Pooled

dependent variable	independent variable										n=105
	lairvalue	*t-stats*		*lairweight*	*t-stats*		*dum1*	*t-stats*		*year*	R2
lairhhi	−0.228	−4.99	***				0.375	2.41	**	−	0.269
lairhhi				−0.304	−6.12	***	0.315	2.11	**	−	0.337

***: significant at 1% level **: siginificant at 5% level *: significant at 10% level

Year : statistically significant (5% level) year dummy.